UPDATE
US EPA-APPROVED
TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR THE
MORA RIVER (HIGHWAY 434 TO LUNA CREEK)

NOVEMBER 28, 2011

This page left intentionally blank.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

***COVER PHOTO**: Upstream view of the Mora River channel and surrounding landscape near the Village of Chacon, May 16, 2006*

LIST OF ABBREVIATIONS

4Q3	4-day, 3-year low-flow frequency
BMP	Best management practices
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CWA	Clean Water Act
HQCWAL	High quality cold water aquatic life
HUC	Hydrologic unit code
LA	Load allocation
lbs/day	Pounds per day
mg/L	Milligrams per liter
mi^2	Square miles
MOS	Margin of safety
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-Sector General Storm Water Permit
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
SC	Specific conductance
SWPPP	Storm Water Pollution Prevention Plan
SWQB	Surface Water Quality Bureau
TDS	Total dissolved solids
TMDL	Total maximum daily load
TSS	Total suspended solids
EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (NMAC 20.6.4 as amended through December 1, 2010)
µmhos/cm	Micromhos per centimeter

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL verifies the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and background conditions, and includes a Margin of Safety (MOS).

EPA received a National Pollutant Discharge Elimination System (NPDES) permit application (NM0031097) from Mora High School in Mora, NM on October 18, 2010. According to the application,

> "*Mora High School is located on the floor of a mountain valley containing a shallow alluvial aquifer, which is capped in most places by a thin layer of low-permeability clay… At the site of the Mora High School athletic facility, which is now in the process of construction, part of the overlaying clay layer was removed during construction activities. In the absence of part of the low-permeability clay layer, rising ground water now reaches the land surface… causing flooding that would render the athletic facility unusable, and would threaten proposed structures.*"

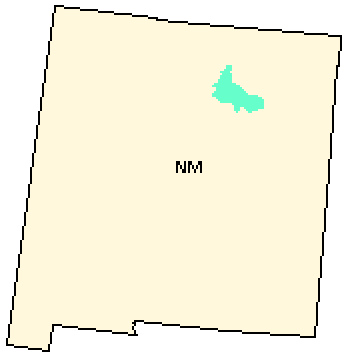
Mora High School has requested an NPDES permit to use a dewatering system that will lower groundwater levels to a safe depth below the surface of the athletic facility and surrounding structures. The dewatering system consists of three wells that will pump shallow ground water to a pipeline and carry the water directly to an outfall at the Mora River (Highway 434 to Luna Creek). It was specifically noted in the permit application that the dewatering system would exclude stromwater and any stormwater generated by precipitation on the athletic facility itself is drained to a separate system with connecting detention ponds.

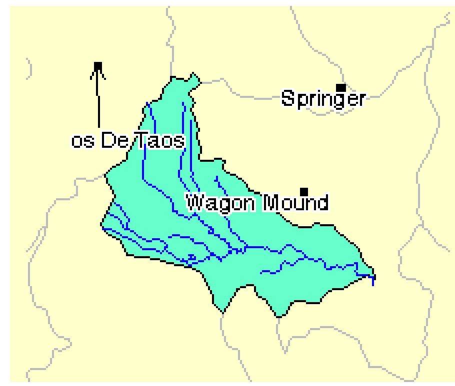
The Mora River watershed is located in northeastern New Mexico. The Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Mora River basin in 2002. Water quality monitoring stations were located within the watershed to evaluate the impact of tributary streams and ambient water quality conditions. As a result of assessing data generated during this monitoring effort impairment determinations of New Mexico water quality standards for **specific conductance** and **sedimentation/siltation** were determined for Mora River (Hwy 434 to Luna Creek). TMDLs for these impairments were approved by EPA in September 2007. This document is an update to the Canadian River Watershed – Part 1 TMDL document, in particular it is an update to the specific conductance and sedimentation/siltation TMDLs for the Mora River (Highway 434 to Luna Creek) in response to Mora High School's NPDES permit application.

Additional water quality data will be collected by the SWQB during the standard rotational period for intensive stream surveys. As a result, targets will be re-examined and potentially revised as this document is considered to be an evolving management plan. When water quality standards have been achieved, the reach will be moved to the appropriate category on the Integrated Clean Water Act §303(d)/§305(b) list of waters.

The draft TMDL was made available for a 30-day comment period beginning on June 6, 2011 and ended July 8, 2011. A public meeting was held at the Mora Independent School District Board Room on June 21, 2011. No written public comments were received.

TOTAL MAXIMUM DAILY LOADS FOR
MORA RIVER (HWY 434 TO LUNA CREEK)





New Mexico Standards Segment	Mora River Basin 20.6.4.309
Waterbody Identifier	NM-2306.A_000
Segment Length	17.90 miles
Parameters of Concern	Specific Conductance; Sedimentation/Siltation
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Mora USGS Hydrologic Unit Code 11080004
Scope/size of Watershed	144.5 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	84% Forest; 13% Grassland; 2% Shrubland; 1% Agriculture
Probable Sources	Natural Sources; Rangeland Grazing; Silviculture Harvesting
Land Management	68% Private; 32% Forest Service
IR Category	5/5B
Priority Ranking	High
TMDL for:	**WLA + LA + MOS = TMDL**
Specific Conductance	**12,970 + 3,754 + 663 = 17,387 lbs/day of TDS**
Sedimentation/Siltation	**318 + 92.7 + 16.3 = 427 lbs/day of TSS**

1.0 SPECIFIC CONDUCTANCE

During the 2002 SWQB water quality survey of the Mora River, exceedences of the NM water quality criterion for Specific Conductance (SC) were documented in the Mora River (Highway 434 to Luna Creek). The following subsections present the SC TMDL for this impaired reach.

According to the NM water quality standards (20.6.4.119 NMAC), the standard for SC reads:

> *In any single sample: specific conductance 500 µmhos/cm or less. . .*

1.1 Target Loading Capacity

Target values for specific conductance (SC) TMDLs are determined based on 1) the presence of numeric criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. The NM Water Quality Control Commission (WQCC) has adopted a numeric water quality criterion for SC to protect the designated use of High Quality Coldwater Aquatic Life (HQCWAL). The numeric criterion for SC applicable to the upper Mora River is 500 µmhos/cm.

1.2 Flow

SC in a stream can vary as a function of flow. As flow decreases, the concentration of TDS can increase, thereby increasing the SC. Similarly, as flows decline, temperatures have a tendency to increase, thus affecting SC values. This TMDL is calculated at a specific flow.

The flow value used to calculate the TMDL for SC on the upper Mora River was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day period discharge that will not fall below that discharge at least every 3 years (Waltemeyer 2002). Low flow was chosen as the critical flow because of the negative effect decreasing, or low, flows have on SC.

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. The 4Q3 derivation for the upper Mora River was based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5} \; DA^{0.70} \; P_w^{\;3.58} \; S^{1.35} \qquad \text{(Eq. 1)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (square miles)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for the upper Mora River was estimated using the regression equation for mountainous regions (**Equation 1**) because the mean elevation for this assessment unit was above 7,500 feet in elevation (Table 1.1).

Table 1.1 Calculation of 4Q3 Low-Flow Frequency

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean Winter Precipitation (in.)	Average Basin Slope (percent)	4Q3 (cfs)
Mora River (Hwy 434 to Luna Creek)	8927	144.49	11.3	26.0	2.276

The 4Q3 value was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$2.276\frac{ft^3}{\sec}\times 1{,}728\frac{in^3}{ft^3}\times 0.004329\frac{gal}{in^3}\times 86{,}400\frac{\sec}{day}\times 10^{-6}=1.471mgd$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained.

1.3 Calculations

In establishing a target for the Mora River, NMED considered the April 25, 2006 District of Columbia Court of Appeals decision (*Friends of the Earth, Inc. v. EPA et al*). The Court of Appeals has now made it necessary for TMDLs to include a "*daily load*" calculation; however it is impossible to calculate a "*daily load*" for specific conductance (SC) because the units (µmhos/cm) cannot be converted to a daily load (pounds per day). Therefore, target values for SC are based on the reduction in total dissolved solids (TDS) necessary to achieve the numeric SC standard.

SC may be used to estimate the total ion concentration of a surface water sample, and is often used as an alternative measure of dissolved solids. In order to calculate a load in pounds per day (lbs/day), TDS is used as a surrogate for SC. The TDS to SC ratio ranges from 0.5 to 0.9 milligrams per liter (mg/L)/micromhos per centimeter (µmhos/cm) (American Public Health Association [APHA] 1998). Specific correlation should be derived by site, if TDS values are available. The TDS to SC ratio for the upper Mora River was calculated, and averaged, resulting in a TDS:SC ratio of 0.72.

As stated previously, the numeric criterion for SC that is protective of the high quality coldwater aquatic life use in the upper Mora River is 500 μmhos/cm or less. The TDS concentration required to achieve this criterion is defined by **Equation 2**.

$$\text{TDS (mg/L)} \cong \text{SC } (\mu\text{mhos/cm}) \times \text{(TDS:SC ratio)} \qquad \text{(Eq. 2)}$$

Using the TDS:SC ratio of 0.72 and an SC value of 500 μmhos/cm, the TDS concentration required to achieve NM WQS in the upper Mora River is:

$$500\ \mu\text{mhos/cm} \times (0.72) \cong 360 \text{ mg/L of TDS}$$

For the purpose of TMDL development, this TDS translator was used. The target load for TDS was calculated by multiplying the combined flow (maximum daily flow rate from Mora High School plus the 4Q3 flow of the river) by the TDS translator for SC (i.e., 360 mg/L of TDS) and a conversion factor of 8.34 that is used to convert flow * concentration (mgd*mg/L) units to pounds per day (lbs/day).

Combined Flow (mgd) x TDS Translator (mg/L) x 8.34 = (Eq. 3)
Total Maximum Daily Load (lbs/day)

The target load, or Total Maximum Daily Load (TMDL), predicted to attain standards was calculated using **Equation 3** and is shown in Table 1.2.

Table 1.2 Calculation of Target Load for TDS (SC surrogate)

Assessment Unit	**Flow[(a)] (mgd)**	**Target TDS[(b)] Concentration (mg/L)**	**Conversion Factor[(c)]**	**TMDL (lbs/day)**
Mora River (Hwy 434 to headwaters)	5.791	360	8.34	17,387

__**Notes**__:

(a) Combined flow based on maximum daily flow rate of Mora HS dewatering system (4.32 mgd) plus 4Q3 of stream (1.471 mgd)
(b) TDS is used as a surrogate measure for SC to calculate a load in lbs/day (refer to Equation 2).
(c) Used to convert flow * concentration units (mgd*mg/L) to pounds per day (lbs/day).

Background loads were not possible to calculate in this watershed. A reference reach, having similar stream channel morphology and flow, was not found. It is assumed that all or a portion of the LA is made up of natural background loads.

1.4 Waste Load Allocations and Load Allocations

1.4.1 Waste Load Allocation

This TMDL is being updated because Mora High School has applied for a NPDES permit to discharge directly into the Mora River (Highway 434 to Luna Creek). Each NPDES-permitted facility (approved or under review) that discharges into an impaired reach has a wasteload allocation (WLA) included in this TMDL (Table 1.3).

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in this AU; however, TDS may be a component of some (primarily construction) storm water discharges covered under general NPDES permits, so the load for these dischargers should addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

Table 1.3 Waste Load Allocation for TDS (SC Surrogate)

Assessment Unit	Facility	Maximum Daily Flow Rate (mgd)	TDS Effluent Limit[(a)] (mg/L)	Conversion Factor[(b)]	Waste Load Allocation (lbs/day)
Mora River (Highway 434 to Luna Creek)	**NM0031097** Mora High School Dewatering Wells (recently submitted – not approved)	4.32	360	8.34	12,970

Notes: *(a)* TDS is used as a surrogate measure for SC to calculate a load in lbs/day (refer to Section 1.3, Eq. 2).
(b) Used to convert flow * concentration units (mgd*mg/L) to pounds per day (lbs/day).

1.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity (TMDL), as shown below in **Equation 4**.

$$WLA + LA + MOS = TMDL, \text{ or}$$
$$LA = TMDL - WLA - MOS \qquad \text{(Eq. 4)}$$

Results using a MOS of 15% (as explained in Section 1.6), are presented in Table 1.4.

Table 1.4 Allocation of TMDL for TDS (SC Surrogate)

Assessment Unit	WLA (lbs/day)	LA (lbs/day)	MOS (15%) (lbs/day)	TMDL (lbs/day)
Mora River (Hwy 434 to Luna Creek)	12,970	3,754	663*	17,387

NOTE: * The MOS was calculated as 15% of the nonpoint source Load Allocation, or MOS = 0.15 × (TMDL – WLA).

1.5 Identification and Description of Pollutant Source(s)

Pollutant sources that could contribute to the upper Mora River are listed in Table 1.5.

Table 1.5 Pollutant Source Summary for Mora River (Highway 434 to Luna Creek)

Pollutant	Magnitude+ (lbs/day)	Probable Sources* (% from each)
Point Source		
TDS	12,970	72% NM0031097 – Mora High School Dewatering Wells
Nonpoint Source		
TDS	4,969	28% Natural Sources; Rangeland Grazing; Silviculture Harvesting

Notes:

+ *Point Source* magnitude is based on the WLA calculation from Table 1.3. *Nonpoint Source* magnitude is equal to the measured load.

* From the Integrated CWA 303(d)/305(b) List (NMED/SWQB 2010). A mineral spring in the area and inflow from wetlands may be contributing to exceedences of specific conductance. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

1.6 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For this TMDL, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

  Using the 4Q3 critical low flow "worst case scenario" to calculate the allowable loads.

  Using the maximum daily flow rate for calculating the point source load even though under most conditions Mora High Shool will not discharge continuously and will not be pumping at full capacity.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in sampling nonpoint sources of pollution. Accordingly, an explicit MOS of **10 percent** of the nonpoint source Load Allocation (LA) was assigned to this TMDL.

  Flow was based on the estimation of the 4Q3 for ungaged streams and compared to actual flows and cross-sectional information taken in the field. Techniques used for measuring flow in water have a ± 5 percent precision. Accordingly, an explicit MOS of **5 percent** of the nonpoint source LA was assigned to this TMDL.

  Therefore, based on the potential errors described above, a conservative, explicit MOS of 15% of the LA was assigned to this TMDL.

1.7 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons in order to ensure coverage of any potential seasonal variation in the system. Exceedences were observed from May through October, which are months that capture the spring runoff, summer monsoonal rains, and baseflow conditions.

1.8 Future Growth

Estimates of future growth are not anticipated to lead to a significant increase in specific conductance that cannot be controlled with best management practice (BMP) implementation in this watershed.

2.0 SEDIMENTATION/SILTATION (STREAM BOTTOM DEPOSITS)

2.1 Target Loading Capacity

Target values for sedimentation/siltation TMDLs are determined based on 1) the presence of numeric criteria or appropriate numeric translator to a narrative standard, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. The state of New Mexico has developed and adopted a narrative standard for "bottom deposits." The current general narrative standard for the deposition of material on the bottom of a stream channel is specifically found in Paragraph (1) of Subsection A of 20.6.4.13 of the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC):

> ***A. Bottom Deposits and Suspended or Settleable Solids:***
> ***(1)*** *Surface waters of the state shall be free of water contaminants including fine sediment particles (less than two millimeters in diameter), precipitates or organic or inorganic solids from other than natural causes that have settled to form layers on or fill the interstices of the natural or dominant substrate in quantities that damage or impair the normal growth, function, or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.*

Excessive stream bottom deposits impact a stream's health by reducing the interstitial space and subsequently reducing intergravel dissolved oxygen, which adversely impact the macroinvertebrate population by reducing the stream's spawning and rearing potential. From a channel morphology vantage point, increasing cobble embeddedness reduces channel roughness (Manning's "n"), thus reducing instream bed friction, which ultimately leads to further channel instability. By addressing sources of suspended sediment (i.e. watershed disturbances) that contribute to instream total suspended solids (TSS), there should be an improvement in biological community and reduction in the amount of deposition and embeddedness overtime, thus improving overall stream health. For this TMDL update, the target value is based on the reduction in TSS necessary to achieve the narrative standard.

<u>Target Setting</u>

The State uses a reference watershed approach when developing TMDLs for sediment. The reference site for this TMDL is Rio la Casa at the inactive USGS gage 7-2148. Rio la Casa at the inactive USGS gage 7-2148 was chosen as the benthic macroinvertebrate reference station for the Mora River at Cleveland near Bridge on Church Rd. The reference and study sites are in the same ecoregion (Southern Rockies) and have similar geomorphic characteristics as displayed in Table 2.1.

Selection of those metrics that are particularly suited to the delineation of sediment impacts highlights the degree of impairment. Pebble counts were collected at both stations according to methods described by Wohlman (1954). Select results of the pebble count and habitat surveys are shown in Table 2.2.

Table 2.1 Geomorphic Characteristics of Reference and Study Sites

Dimensions	Reference Site[(a)]	Study Site[(b)]
Cross-section Area (sq. ft.)	27.8	53.1
Width (feet)	17.4	29.5
Maximum Depth (feet)	2.4	2.5
Mean Depth (feet)	1.6	1.8
Width:Depth Ratio	10.9	16.4
Entrenchment Ratio	5.75	1.27

Notes:
(a) Reference Site = Rio la Casa at inactive USGS gage 7-2148 (2002 Data)
(b) Study Site = Mora River at Cleveland by Bridge on Church Rd. (2002 Data)

Table 2.2 Pebble Count and Habitat Results

Results	Reference Site[(a)]	Study Site[(b)]	Percent of Reference
Pebble count			
% Fines (< 2 mm)	15	51	240%
D50	75.9 mm	0.1 mm	—
D84	181 mm	76 mm	—
Total Habitat Score (out of a possible 200)	***176***	***96***	***55%***

Notes:
(a) Reference Site = Rio la Casa at inactive USGS gage 7-2148 (2002 Data)
(b) Study Site = Mora River at Cleveland by Bridge on Church Rd. (2002 Data)
mm = Millimeters — = Not applicable

In establishing a target for the Mora River, NMED considered several factors. First, the April 25, 2006 District of Columbia Court of Appeals decision (*Friends of the Earth, Inc. v. EPA et al*), has now made it necessary for TMDLs to include "*daily load*" calculation. Currently the Clean Water Act Section 303(d)(1)(C) requires that TMDLs be established for pollutants which are, "suitable for calculation." In this case it is impossible to calculate a "*daily load*" for stream bottom deposits based on "percent fines." Secondly, the Mora River watershed (Figure 2.1) has both natural processes and watershed disturbances (both anthropogenic and non-anthropogenic) that contribute to sediment deposition. Therefore, this TMDL will focus on reducing TSS.

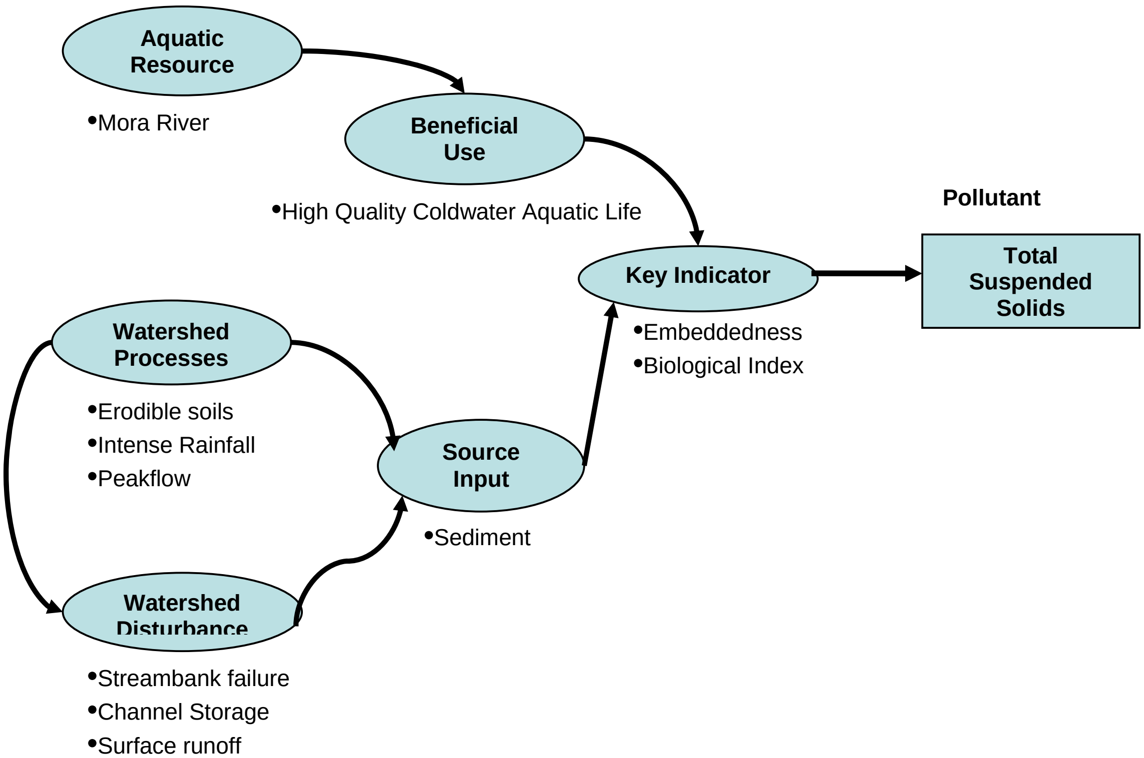


Figure 2.1 Sediment Issues and TMDL Target Setting

In examining the existing water quality data for the Mora River, limited streamflow, TSS, and turbidity data were available (Table 2.3). Analyzing the water quality data by station was impracticable because the data were limited. Therefore, the data were aggregated and an analysis was performed on the entire dataset which represents the entire segment.

Table 2.3 Available Water Quality Data for the Mora River

	Number of Samples		
Mora River (Hwy 434 to Luna Creek)	**TSS**	**Turbidity**	**Flow**
Mora River at Chacon 0.6 miles above gage	9	9	8
Mora River at Cleveland by bridge on Church Rd.	9	9	9
Total Available Data Points	**18**	**18**	**17**

The segment-specific or use-specific turbidity values from the 2002 State of New Mexico Surface Water Quality Standards were used to obtain an in-stream target value. Based on the 2002 State standards, it was determined that a turbidity value of 25 NTU is the target that should be protective of the high quality coldwater aquatic use in the upper Mora River, remembering that in order to calculate a load in pounds per day (lbs/day) TSS is used as a surrogate for stream bottom deposits. Figure 2.2 depicts the relationship between TSS and turbidity for the upper Mora River (R^2 = 0.28).

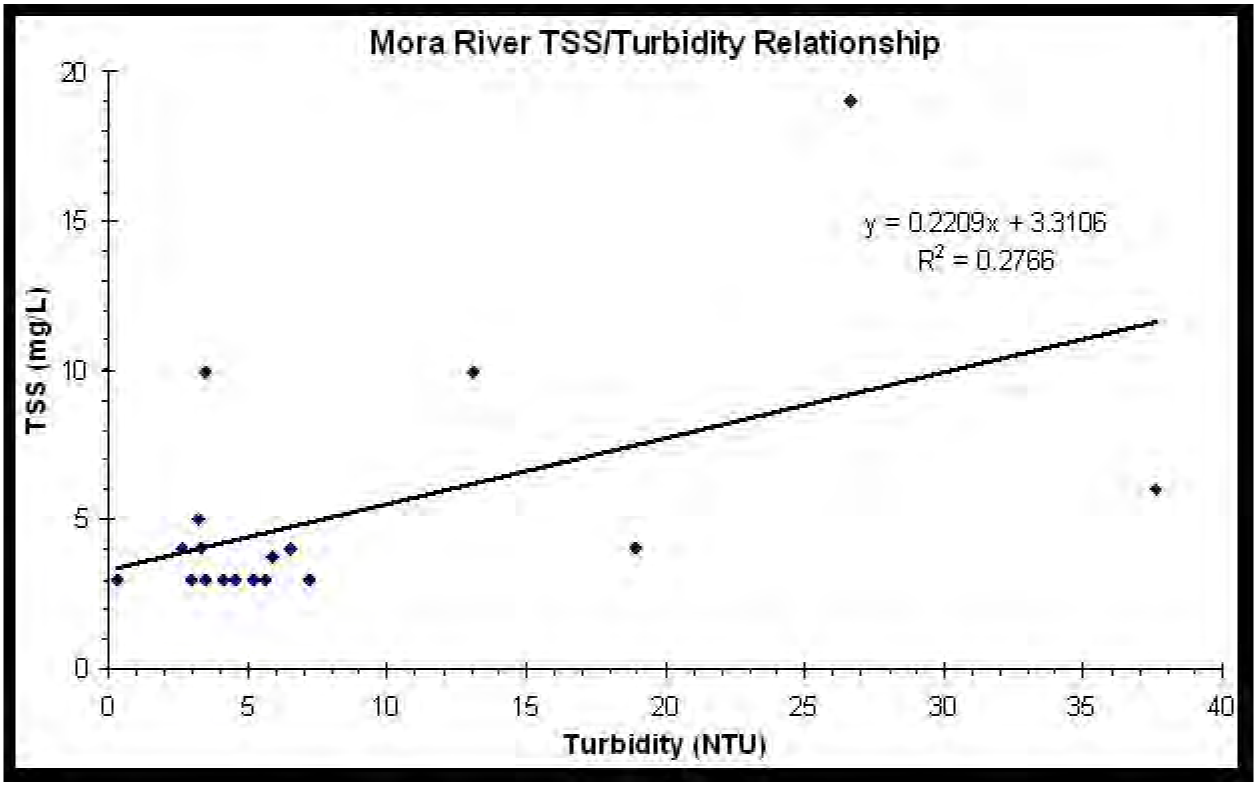


Figure 2.2 Upper Mora River TSS vs. Turbidity Relationship

The data show that 28% of the variability in turbidity is explained by TSS. In addition, Pearson correlation coefficient was used to assess whether a statistical association existed between TSS and turbidity. Pearson correlation coefficient measures the strength and direction of a *linear* relationship between *X* and *Y* variables. Like other numerical measures, the population correlation coefficient is "ρ" (the Greek letter "rho") and the sample correlation coefficient is denoted by *r*.

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

When examining the entire data set, the data for the upper Mora River show a positive association between TSS and turbidity (r = 0.53). The relationship between TSS and turbidity demonstrates that potential sources of suspended sediment impact both TSS and turbidity.

Using the TSS/Turbidity relationship from Figure 2.2 and a turbidity target of 25 NTU, the TSS concentration required to achieve NM water quality standards in the upper Mora River is:

$$(0.2209 \times 25 \text{ NTU}) + 3.3106 \cong 8.83 \text{ mg/L of TSS}$$

2.2 Flow

Sediment transport in a stream varies as a function of flow. As flow increases, the amount of sediment being transported increases. Conversely, as flows decline the sediment that was suspended during higher flows has a tendency to settle out, thus affecting the total percent fines on a stream bottom.

This TMDL is calculated at a specific flow. The flow value used to calculate the TMDL for SC on the upper Mora River was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day period discharge that will not fall below that discharge at least every 3 years (Waltemeyer 2002). Low flow was chosen as the critical flow because of the negative effect decreasing, or low, flows have on bottom deposits.

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. The 4Q3 derivation for the upper Mora River was based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 1)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (square miles)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for the Mora River was estimated using the regression equation for mountainous regions (**Equation 1**) because the mean elevation for this assessment unit was above 7,500 feet in elevation (Table 2.4).

Table 2.4 Calculation of 4Q3 Low-Flow Frequency

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean Winter Precipitation (in.)	Average Basin Slope (percent)	4Q3 (cfs)
Mora River (Hwy 434 to Luna Creek)	8927	144.49	11.3	26.0	2.276

The 4Q3 value was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$2.276\ \frac{ft^3}{\sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400\ \frac{\sec}{day} \times 10^{-6} = 1.471\,mgd$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow.

2.3 Calculations

The target load for stream bottom deposits (expressed as TSS) was calculated by multiplying the combined flow (maximum daily flow rate from Mora High School plus the 4Q3 flow of the river) by the TSS translator (i.e., 8.83 mg/L of TSS) and a conversion factor of 8.34 that is used to convert flow * concentration (mgd*mg/L) units to pounds per day (lbs/day).

Combined Flow (mgd) x TSS Translator (mg/L) x 8.34 =
Total Maximum Daily Load (lbs/day) (Eq. 2)

The target load, or Total Maximum Daily Load (TMDL), predicted to attain standards was calculated using **Equation 2** and is shown in Table 2.5.

Table 2.5 Calculation of Target Load for TSS (Sedimentation/Siltation surrogate)

Assessment Unit	Flow[(a)] (mgd)	TSS Target[(b)] (mg/L)	Conversion Factor[(c)]	Target Load Capacity (lbs/day)
Mora River (Hwy 434 to Luna Creek)	5.791	8.83	8.34	427

Notes:
(a) Combined flow based on maximum daily flow rate of Mora HS dewatering system (4.32 mgd) plus 4Q3 of stream (1.471 mgd)
(b) TSS is used as a surrogate measure for sediment to calculate a load in lbs/day (refer to Section 2.1 – *Target Setting*). The TSS target was calculated using the relationship established between TSS and turbidity in Figure 2.2 substituting the 2002 turbidity standard of 25 NTU for "x" [TSS = 0.2209x + 3.3106].
(c) Used to convert flow * concentration units (mgd*mg/L) to pounds per day (lbs/day).

2.4 Waste Load Allocations and Load Allocations

2.4.1 Waste Load Allocation

This TMDL is being updated because Mora High School has applied for an NPDES permit to discharge directly into the Mora River (Highway 434 to Luna Creek). Each NPDES-permitted facility (approved or under review) that discharges into an impaired reach has a wasteload allocation (WLA) included in this TMDL (Table 2.6).

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in this AU; however, sediment may be a component of some (primarily construction) storm water discharges covered under general NPDES permits, so the load for these dischargers should addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

Table 2.6 Waste Load Allocation for TSS (Sedimentation/Siltation surrogate)

Assessment Unit	Facility	Maximum Daily Flow Rate (mgd)	TSS Effluent Limit[(a)] (mg/L)	Conversion Factor[(b)]	Waste Load Allocation (lbs/day)
Mora River (Highway 434 to Luna Creek)	**NM0031097** Mora High School Dewatering Wells (recently submitted – not approved)	4.32	8.83	8.34	318

Notes: *(a)* TSS is used as a surrogate measure for sediment to calculate a load in lbs/day (refer to Section 2.1 – *Target Setting*).
(b) Used to convert flow * concentration units (mgd*mg/L) to pounds per day (lbs/day).

2.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity TMDL following **Equation 3**:

$$WLA + LA + MOS = TMDL,\ or$$
$$LA = TMDL - WLA - MOS \qquad \text{(Eq. 3)}$$

Results using a MOS of 15% (as explained in Section 2.6), are presented in Table 2.7.

Table 2.7 Allocation of TMDL for TSS (Sedimentation/Siltation surrogate)

Assessment Unit	WLA (lbs/day)	LA (lbs/day)	MOS (15%) (lbs/day)	TMDL (lbs/day)
Mora River (Hwy 434 to Luna Creek)	318	92.7	16.3*	427

NOTE: * The MOS was calculated as 15% of the nonpoint source Load Allocation, or MOS = 0.15 × (TMDL – WLA).

2.5 Identification and Description of Pollutant Source(s)

Pollutant sources that could contribute to the upper Mora River are listed in Table 2.8.

Table 2.8 Pollutant Source Summary for Mora River (Highway 434 to Luna Creek)

Pollutant	Magnitude+ (lbs/day)	Probable Sources* (% from each)
Point Source		
TSS	318	85% NM0031097 – Mora High School Dewatering Wells
Nonpoint Source		
TSS	54.7	15% Natural Sources; Rangeland Grazing; Silviculture Harvesting

Notes:
+ *Point Source* magnitude is based on the WLA calculation from Table 2.6. *Nonpoint Source* magnitude is equal to the measured load estimated as: Average TSS concentration (4.46 mg/L) × 4Q3 Flow (1.471 mgd) × Conversion Factor (8.34).
* From the Integrated CWA 303(d)/305(b) List (NMED/SWQB 2010). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

2.6 Margin of Safety (MOS)

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For this TMDL, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

  Using the 4Q3 critical low flow “worst case scenario” to calculate the allowable loads.

  Using the maximum daily flow rate for calculating the point source load even though under most conditions Mora High Shool will not discharge continuously and will not be pumping at full capacity.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in sampling nonpoint sources of pollution. Accordingly, an explicit MOS of **10 percent** of the nonpoint source Load Allocation (LA) was assigned to this TMDL.

Flow was based on the estimation of the 4Q3 for ungaged streams and compared to actual flows and cross-sectional information taken in the field. Techniques used for measuring flow in water have a ± 5 percent precision. Accordingly, an explicit MOS of **5 percent** of the nonpoint source LA was assigned to this TMDL.

Therefore, based on the potential errors described above, a conservative, explicit MOS of 15% of the LA was assigned to this TMDL.

2.7 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons in order to ensure coverage of any potential seasonal variation in the system. Fall is a critical time in the life cycle stages of benthic macroinvertebrates in New Mexico. Fall is also generally the low-flow period of the mean annual hydrograph in New Mexico when bottom deposits are most likely to settle and cause impairment, after the summer monsoon season but before annual spring runoff. Thus, the critical condition used for calculating this TMDL was low flow. It is assumed that if critical conditions are met during this time, coverage of any potential seasonal variation will also be met.

2.8 Future Growth

Estimations of future growth are not anticipated to lead to a significant increase in sedimentation that cannot be controlled with BMP implementation in this watershed.

3.0 REFERENCES

American Public Health Association, American Water Works Association, and Water Environment Federation (APHA). 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition.

New Mexico Administrative Code (NMAC). 2011. State of New Mexico Standards for Interstate and Intrastate Surface Waters. 20.6.4. New Mexico Water Quality Control Commission. As amended through January 14, 2011. (20.6.4 NMAC)

New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB). 2010. State of New Mexico 2010-2012 Integrated Clean Water Act §303(d)/§305(b) List of Assessed Waters. July 29, 2010. Santa Fe, NM.

Waltemeyer, Scott D. 2002. Analysis of the Magnitude and Frequency of the 4-Day Annual Low Flow and Regression Equations for Estimating the 4-Day, 3-Year Low-Flow Frequency at Ungaged Sites on Unregulated Streams in New Mexico. USGS Water-Resources Investigations Report 01-4271. Albuquerque, New Mexico.

Wohlman, M.G. 1954. A method of sampling coarse riverbed material. Transactions of American Geophysical Union. Vol. 35, pp. 951-956.